Package 'rdbounds'

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Title Manipulation Robust Regression Discontinuity Bounds Estimation

Version 1.0

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Description This package implements the estimation procedure in Gerard, Rokka-
nen, and Rothe (2018) to estimate bounds on treatment effects under potential manipula-
tion of the running varible. This is a preliminary version and is still undergoing testing. We ap-
preciate hearing any comments or issues noted.

URL <http://www.nber.org/papers/w22892>

Imports data.table,
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R topics documented:

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rdbounds   *Manipulation Robust Regression Discontinuity Bounds Estimation*

Description

This function implements the estimation procedure in Gerard, Rokkanen, and Rothe (2018) to estimate bounds on treatment effects under potential manipulation of the running varible. Returns an rdbounds object, which can then be passed to [rdbounds_summary](#) and [rdbounds_export](#). Note on refinements: "Refinement A" calculates bounds based on the assumption that always-assigned units are at least as likely to receive treatment than potentially-assigned units (Theorem 3 in paper). "Refinement B" calculates bounds based on the assumption that always-assigned units *always* receive treatment (Theorem 4 in paper).

Usage

```
rdbounds(y, x, covs = NULL, treatment = NULL, c = 0, discrete_x = FALSE,
  discrete_y = FALSE, bwsx, bwy = NULL, kernel = "triangular",
  orders = array(1, dim = c(2)), evaluation_ys = NULL, ymin = NULL,
  ymax = NULL, type = "ate", percentiles = NULL, num_tau_pairs = 50,
  refinement_A = FALSE, refinement_B = FALSE, right_effects = FALSE,
  yextremes = NULL, num_lambdas = 50, num_bootstraps = c(100, 20),
  Kn = NULL, alpha = 0.05, potential_taus = NULL, parallelize = TRUE,
  progressFile = NULL, warningsFile = NULL, kernel_y = NULL,
  bwsxcov = NULL, bwycov = NULL, CDFinputs = list(original = NULL, CIsetup
  = NULL))
```

Arguments

y	specifies the outcome/dependent variable. Required.
x	specifies the running variable that determines eligibilty for treatment. Required.
covs	specifies covariates to implement the covariate-based refinement. Expected as a single factor variable.
treatment	specifies the treatment status variable if implementing a Fuzzy RDD. Defaults to computation of Sharp RDD results only.
c	specifies the threshold for assignment to treatment (assigned iff x >= c). Defaults to 0.
discrete_x	Boolean. If TRUE, treat each value of x as a mass-point for density estimation. Defaults to FALSE.
discrete_y	Boolean. If TRUE, treat each value of y as a mass-point for density estimation. Defaults to FALSE.
bwsx	is a vector of bandwidths in x, respectively for 1) estimation of the discontinuity in the density of x at the cutoff; and 2)local polynomial estimation of conditional means. Expects either a single bandwidth to be used for both or a vector of two. Required.
bwy	is a bandwidth for density estimation of y, implemented if discrete_y=FALSE. Required if discrete_y=FALSE.
kernel	specificies a kernel function to be used throughout estimation for x. Choices are triangular, rectangular, gaussian and epanechnikov. Defaults to triangular.
orders	specifies the order of polynomial regression, for: 1) estimation of the discontinuity in the density at the cutoff (τ in paper), and 2) local polynomial regressions. Expects either a single integer to be used for both or a vector of two values. Defaults to 1 (local linear regression) for all. Estimation of τ can only be implemented up to quadratic order if discrete_X=FALSE.

evaluation_ys	an explicit vector of y-values to evaluate CDF's at (and PDF's if `discrete_y = FALSE`). If `evaluation_ys` is not set, the set of unique values of y in the sample will be used. Caution is required if `discrete_y=TRUE`, because computation will assume a probability mass function can be estimated from differences in estimated CDF's at subsequent values of `evaluation_ys`. This can bias FRD estimates if `evaluation_ys` does not contain all values in the support of y.
ymin	left/lower bound on y at which to implement a boundary kernel correction if `discrete_y=FALSE` and y is a variable with bounded support (e.g. after censoring). Defaults to `NULL`, meaning no boundary kernel correction is implemented on the left side of the support of y.
ymax	right/upper bound on y at which to implement a boundary kernel correction if `discrete_y=FALSE` and y is a variable with bounded support (e.g. after censoring). Defaults to `NULL`, meaning no boundary kernel correction is implemented on the left side of the support of y.
type	"ate" for average treatment effects (default) or "qte" for quantile treatment effects at the percentiles given by parameter `percentiles`. Defaults to `ate`.
percentiles	vector of percentiles at which to asses quantile treatment effects. Defaults to median (.5). User may add -1 as a percentile, in order to estimate average treatment effects along with QTE's. For example, `percentiles=c(-1,.3,.5)` will compute ATEs as well as the 30 percent and 50 percent QTEs
num_tau_pairs	integer number of points to search over in the set of possible values for (τ_0, τ_1) in notation of paper, for fuzzy RD estimation. Defaults to 50. If set to 1, the single tau is set to the "rightmost" (t=1) extreme of the set T, such that user can enforce the assumption that always-assigned units always receive treatment (see below), if this is consistent with data.
refinement_A	Boolean. If `TRUE`, additionally calculate refined bounds with the restriction that always assigned units are at least as likely to be treated as potentially assigned units (i.e. $\tau_1 \geq \tau$; see Corollary 1 in paper) Defaults to FALSE.
refinement_B	Boolean. If `TRUE`, additionally calculate refined bounds for `right_effects` with the restriction that always assigned units on the right side of the cutoff are always treated (i.e. $\tau_0 = 0$; see Corollary 2 in paper) Defaults to FALSE.
right_effects	boolean. If set to `TRUE`, additionally estimate causal effects for units just to the right of the cutoff. Defaults to `FALSE`.
yextremes	extreme values Y_L and Y_U to assume if `right_effects=TRUE`, e.g. `yextremes=c(0,100)`. Defaults to the sample range of y.
num_lambdas	integer number of points to search over for the causal effect of units just to the right of the cutoff (lambda in paper). Defaults to 50.
num_bootstraps	A vector of the number of bootstrap resamples desired, where the first component is the number of bootstrap samples for estimating confidence intervals, and the second is the number of samples for diagnostic testing of the estimated discontinuity in the density at the cutoff. If a scalar is given, the same number is used for both. Defaults to `num_bootstraps = c(100,20)`. To avoid bootstrap testing altogether, set `num_bootstraps=NULL` or `num_bootstraps=c(0,0)`.
Kn	a hardcoded constant for κ_n (see Section 5.2 on inference in paper). Defaults to $log(n)^{1/2}$, where n is the number of observations.
alpha	sets the level for confidence intervals. Defaults to alpha=.05 for 95 percent confidence intervals.
potential_taus	vector of different values of τ to use for the confidence intervals estimating the potential impact of manipulation, e.g. `potential_taus=c(.025, .05, .1, .2)`.

parallelize	indicates whether to parallelize bootstrap computations across the available number of cores on machine, minus one. Defaults to TRUE.
progressFile	a file to output progress to (useful if parallelize=TRUE and the individual cores can't write to screen). File will be appended to.
warningsFile	a file to output full warning messages to from bootstrap estimation if parallelize=TRUE). File will be appended to.
kernel_y	allows a separate kernel for density estimation of y. Same choices as kernel for x. Defaults to kernel specified for use with x.
bwsxcov	an optional separate bwsx to use for quantities that are computed on a subsample conditioned on a value of covs (e.g. covariate-conditional CDFs).
bwycov	an optional separate bwy to use for quantities that are computed on a subsample conditioned on a value of covs (e.g. covariate-conditional CDFs).
CDFinputs	optional, the rdbounds$CDFinputs object from a previous run of rdbounds on the same dataset. This can be used to speed up processing by allowing CDF and PDF estimation to be skipped on a second run.

References

Francois Gerard, Miikka Rokkanen, and Christoph Rothe (2016)."Bounds on Treatment Effects in Regression Discontinuity Designs under Manipulation of the Running Variable, with an Application to Unemployment Insurance in Brazil". NBER Working Paper 22892.

Examples

```
df<-rdbounds_sampledata(50000, covs=TRUE)
rdbounds_est<-rdbounds(y=df$y,x=df$x, covs=as.factor(df$cov), treatment=df$treatment, c=0,
                       discrete_x=FALSE, discrete_y=FALSE, bwsx=c(.2,.5), bwy = .1,
                       kernel="epanechnikov", orders=1,
                       evaluation_ys = seq(from = 0, to=23, by=.2), ymin=0, ymax=23,
                       num_bootstraps=0, refinement_A=TRUE, refinement_B=TRUE,
                       right_effects=TRUE, yextremes = c(0,23))
rdbounds_summary(rdbounds_est, title_prefix="Sample Data Results")
```

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rdbounds_export	*Export Results from Manipulation Robust RD Estimation*

Description

This function exports tables from manipulation robust RD estimation

Usage

```
rdbounds_export(rdbounds, file_name = NULL, view_it = FALSE)
```

Arguments

rdbounds	An rdbounds object resulting from rdbounds. Required.
file_name	base filename to output tables to. Expects a string of the form "path/filename", where filename has no extension and will be the root filename for a series of different files containing different tables. If omitted no files will be produced.
view_it	Boolean. View main results table in Rstudio viewer. Defaults to FALSE.

Examples

```
df<-rdbounds_sampledata(50000, covs=TRUE)
rdbounds_est<-rdbounds(y=df$y,x=df$x, covs=as.factor(df$cov), treatment=df$treatment, c=0,
                       discrete_x=FALSE, discrete_y=FALSE, bwsx=c(.2,.5), bwy = .1,
                       kernel="epanechnikov", orders=1,
                       evaluation_ys = seq(from = 0, to=23, by=.2), ymin=0, ymax=23,
                       num_bootstraps=0, refinement_A=TRUE, refinement_B=TRUE,
                       right_effects=TRUE, yextremes = c(0,23))
rdbounds_summary(rdbounds_est, title_prefix="Sample Data Results")
```

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rdbounds_sampledata   *Generate a simulated dataset for testing estimation*

Description

This function generates a simulated dataset with which to test [rdbounds](). The x-values of potentially-assigned units (95 Specifically:

$$y = (x+10)/2*treatment*(alwaysassigned = 0)+5*treatment*(alwaysassigned = 1)+normal(0,1))$$

and y is censored at 0 and 23.

Usage

```
rdbounds_sampledata(sample_size = 50000, covs = FALSE)
```

Arguments

sample_size   Sample size for the dataset.

covs   If set to TRUE, generates a sample in which half of the units have one of two co-
               variate values, where the proportion of always-assigned units is slightly different
               for each.

Examples

```
df<-rdbounds_sampledata(50000);
```

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rdbounds_summary   *Summarize Results from Manipulation Robust RD Estimation*

Description

This function reports main estimands from [rdbounds](), as a formatted table, and optionally as text output.

Usage

```
rdbounds_summary(rdbounds, title_prefix = "", text = TRUE)
```

Arguments

rdbounds	an rdbounds object resulting from the function rdbounds(). Required.
title_prefix	Optional prefix before "Average Treatment EFfects" or "Quantile Treatment Effects" in table.
text	if set to TRUE, display results as text as well as formatted table. Defaults to TRUE.

Examples

```
df<-rdbounds_sampledata(50000, covs=TRUE)
rdbounds_est<-rdbounds(y=df$y,x=df$x, covs=as.factor(df$cov), treatment=df$treatment, c=0,
                       discrete_x=FALSE, discrete_y=FALSE, bwsx=c(.2,.5), bwy = .1,
                       kernel="epanechnikov", orders=1,
                       evaluation_ys = seq(from = 0, to=23, by=.2), ymin=0, ymax=23,
                       num_bootstraps=0, refinement_A=TRUE, refinement_B=TRUE,
                       right_effects=TRUE, yextremes = c(0,23))
rdbounds_summary(rdbounds_est, title_prefix="Sample Data Results")
```

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